Calibration Software Needs For CAL BFEM

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Mods to recon

What changes are needed to BF CAL recon?

- Energy measurement was poorer than it should have been because
  1. The charge-injection calibration didn't cover bottom and top of each range well enough.
     - Muon peak set the gain scale, but it wasn't well covered by chg-inj.
  2. My quadratic-quadratic gain model wasn't good enough.
     - Some channels just had a different shape.
  3. People used calibrations for time periods for which they weren't valid.
     - Gain calib was not valid for January proton runs, but we used it anyway.
     - Led to false impression that CAL wasn't calibrated.

- **So we need new energy scale fcns in BF recon.**
  - New chg calibration covers full range.
    - I ran pre-ship, will continue to run pre flight.
  - New gain model (piecewise linear).
    - AI: create new ADC_to_fC fcn (Chekhtman)
    - AI: create new fC_to_MeV tables (Grove, Chekhtman)

Operational needs

- Ground calibration of CAL
  - Test and checkout plan, instrument operations
  - During BF payload integration and pre-flight checkout
    - Periodic overnight muon runs
      - To set absolute energy scale
    - Periodic electronic calibrations
      - To set gain scale, linearity
    - One big, long muon run
      - To map all crystals
- See my details for CAL in Eduardo's session

Mods to recon

What changes are needed to BF CAL recon?

- BF will have random mix of photons and particles
  - All subsystems need to work on photon-hadron/nucleus discrimination
  - CAL recon will otherwise merrily try profile fitting on C nuclei!
- BF gives opportunity to put recon in context of Richard's "From Space to Photons" flow chart.

- BF GCRs are useful for developing CAL calibration algorithms.
  - Need photon-nucleus discrimination.
    - Use ACD ULD for first pass.
  - Need TKR recon for trajectories.
  - Need good ground calib of CAL.

Balloon flight GCRs

GCR rates for Palestine balloon flight

- Require passage through uppermost full Si layer and bottom of CsI
- Used CREME96 for 35km above Palestine in 2001, from H to Ni
- See http://gamma.nrl.navy.mil/glast/tech_memos/cremeballoon.pdf

Assuming 8 hrs at float

~4000 CNO

~900 Ne, Mg, and Si

~250 Fe

to play with.

Species	Total rate (per hr)	Non-fragmenting rate (per hr)
C	220	63
N	58	15
O	220	55
Ne	35	8
Mg	46	10
Si	35	7
Fe	29	4

Scope of Task

- Also Ground s/w, but beyond scope of this review

  - CAL ground support equipment (CalGSE)
    - Command generation & control (in use, complete)
    - Command state verification (prototype for balloon flight?)
    - Health & Safety Monitoring (prototype for balloon flight?)
    - Data logging (in use, complete)
    - CAL simulator
  - CAL bench-checkout
    - Low-level analysis, "recon" (in use, extensive suite)

- [Balloon flight is an opportunity to put recon in context of flight data flow, Richard's "From Space to Photons."]

Calorimeter Calibration

- Functional requirements (top level)
  - Electronic calibration: eCalib shall generate pedestal and integral linearity model for each gain range for each PIN diode.
    - Required accuracy is TBD; goal is 3%.
    - Data source is Charge-Injection Calibration Mode.
  - Absolute light yield: GCRCalib shall calculate the absolute light yield at the center of each log for each PIN diode.
    - Required accuracy is TBD; goal is 3%.
    - Data source is GCR Calibration Mode.
  - Light asymmetry model: GCRCalib shall produce maps of light asymmetry (i.e. light collection efficiency as a fcn of longitudinal position) of each log end and the sum of ends for each log.
    - Required accuracy is 10%; goal is 1%.
    - Data source is GCR Calibration Mode.

Calibration Parameter Database

- The various calibration processes produce a number of parameters describing the response of the CsI logs.
  - All are time-dependent (TBR).
  - Time scale is likely to be ~ weeks to months (TBR).
- Calibration Parameter Database is a service of Software Central.

1. Pedestals
   - Accumulated on board
     - Telemetered: pedestal, pedestal width, diagnostic histogram
     - Optional diagnostic mode telemeters full CAL data set, i.e. not zero-suppressed.
       - 2 bytes x 2 parameters x 4 ranges x 2 ends x 1536 logs = 48 kB

2. Differential linearity correction
   - Make the CDB smooth.
     - Worth thinking about some more. Consider 1 byte per ADC bin per range.
       - 1 byte x 4096 channels x 4 ranges x 2 ends x 1536 logs = 50 MB

Calibration Parameter Database

3. Integral linearity correction (ADC to fC)

- Electronic calibration
  - Internal charge-injection circuit; used during in-flight diagnostic mode
    - 4 bytes x 10 parameters x 4 ranges x 2 ends x 1536 logs = 480 kB
- GCR calibration
  - Might uncover additional non-linearities. Might not; thus these might not be used.
    - 4 bytes x 5 parameters x 4 ranges x 2 ends x 1536 logs = 240 kB

4. Gain (optical conversion efficiency: fC to MeV[center of log])

- Accounts for light collection: electrons at preamp per MeV deposited
- Calculated from GCR Calibration data. Updates ground calibration.
  - 4 bytes x 4 ranges x 2 ends x 1536 logs = 48 kB

5. Light attenuation model (MeV[center] to MeV[position])

- Accounts for variation of light collection along each log.
- Calculated from GCR Calibration data. Updates ground calibration.
- Small and large PINs have same light attenuation, so each log has 3 models:
  - Individual ends
    - 4 bytes x 5 parameters x 2 ends x 1536 logs = 60 kB
  - Sum of ends
    - 4 bytes x 5 parameters x 1536 logs = 30 kB